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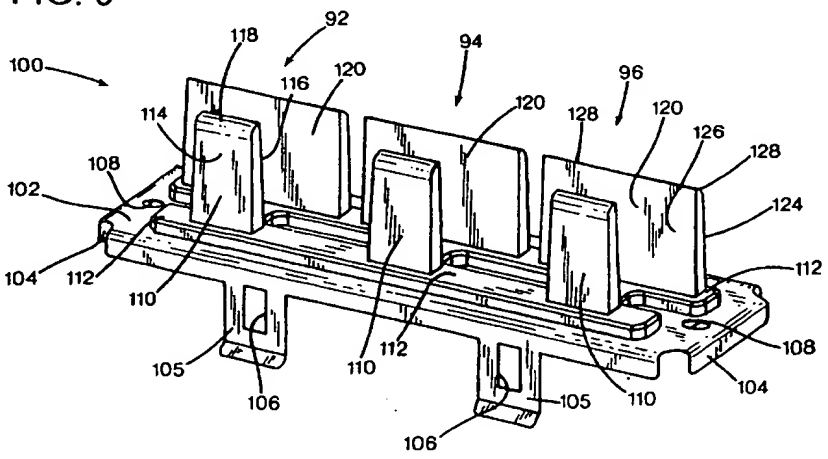
(54) Narrow and wide wiper blade cleaning system for ink jet printheads

(57) A dual-blade wiper system (100; 100'; 100"; 130) for cleaning inkjet printheads (70, 72, 74, 76) in an inkjet printing mechanism (20) gives individual wiping attention to an orifice plate (160) through which ink-ejecting nozzles are formed with a "little-brother blade (110; 140)," while also wiping the entire printhead, including cheek regions (162) of the printhead adjacent the orifice plate (160), using a "big-brother blade (120; 150; 170)." Both blades (110, 120; 140, 150; 110, 170) are onsert molded to a spring steel support platform (102; 132) that carries the blades between rest and servicing positions. Several dual-blade assemblies may be formed on the platform, with all the wider big-brother blades aligned (100), or alternating with the narrower little-brother blades (100'), or a single unitary big-brother blade (100", 170) may be used to wipe several printheads simultaneously. An inkjet printing mechanism (20) having such a dual-blade wiper system (100; 100'; 100"; 130) is also provided.

FIG. 3



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Description

Field of the Invention

[0001] The present invention relates generally to inkjet printing mechanisms, and more particularly to a dual-blade wiper system for cleaning inkjet printheads, giving individual wiping attention to an orifice plate through which ink-ejecting nozzles are formed with a "little-brother blade," while also wiping the entire printhead, including cheek regions of the printhead adjacent the orifice plate, using a "big-brother blade."

Background of the Invention

[0002] Inkjet printing mechanisms use cartridges, often called "pens," which eject drops of liquid colorant, referred to generally herein as "ink," onto a page. Each pen has a printhead formed with very small nozzles through which the ink drops are fired. To print an image, the printhead is propelled back and forth across the page, ejecting drops of ink in a desired pattern as it moves. The particular ink ejection mechanism within the printhead may take on a variety of different forms known to those skilled in the art, such as those using piezo-electric or thermal printhead technology. For instance, two earlier thermal ink ejection mechanisms are shown in U.S. Patent Nos. 5,278,584 and 4,683,481. In a thermal system, a barrier layer containing ink channels and vaporization chambers is located between a nozzle orifice plate and a substrate layer. This substrate layer typically contains linear arrays of heater elements, such as resistors, which are energized to heat ink within the vaporization chambers. Upon heating, an ink droplet is ejected from a nozzle associated with the energized resistor. By selectively energizing the resistors as the printhead moves across the page, the ink is expelled in a pattern on the print media to form a desired image (e.g., picture, chart or text).

[0003] To clean and protect the printhead, typically a "service station" mechanism is supported by the printer chassis so the printhead can be moved over the station for maintenance. For storage, or during non-printing periods, the service stations usually include a capping system which substantially seals the printhead nozzles from contaminants and drying. Some caps are also designed to facilitate priming, such as by being connected to a pumping unit that draws a vacuum on the printhead. During operation, clogs in the printhead are periodically cleared by firing a number of drops of ink through each of the nozzles in a process known as "spitting," with the waste ink being collected in a "spittoon" reservoir portion of the service station. After spitting, uncapping, or occasionally during printing, most service stations have an elastomeric wiper that wipes the printhead surface to remove ink residue, as well as any paper dust or other debris that has collected on the printhead. The wiping action is usually achieved through relative motion of the printhead and wiper, for instance by moving the printhead across the wiper, by moving the wiper across the printhead, or by moving both the printhead and the wiper.

[0004] To improve the clarity and contrast of the printed image, recent research has focused on improving the ink itself. To provide quicker, more waterfast printing with darker blacks ad more vivid colors, pigment-based inks have been developed. These pigment-based inks have a higher solid content than the earlier dye-based inks, which results in a higher optical density for the new inks. Both types of ink dry quickly, which allows inkjet printing mechanisms to form high quality images on readily available and economical plain paper, as well as on recently developed specialty coated papers, transparencies, fabric and other media.

[0005] As the inkjet industry investigates new printhead designs, the tendency is toward using permanent or semi-permanent printheads in what is known in the industry as an "off-axis" printer. In an off-axis system, the printheads carry only a small ink supply across the printzone, with this supply being replenished through tubing that delivers ink from an "off-axis" stationary reservoir placed at a remote stationary location within the printer. Since these permanent or semi-permanent printheads carry only a small ink supply, they may be physically more narrow than their predecessors, the replaceable cartridges. Narrower printheads lead to a narrower printing mechanism, which has a smaller "footprint," so less desktop space is needed to house the printing mechanism during use. Narrower printheads are usually smaller and lighter, so smaller carriages, bearings, and drive motors may be used, leading to a more economical printing unit for consumers.

[0006] There are a variety of advantages associated with these off-axis printing systems, but the permanent or semi-permanent nature of the printheads requires special considerations for servicing, particularly when wiping ink residue from the printheads. This wiping must be accomplished without any appreciable wear that could decrease printhead life, and without using excessive forces that could otherwise un-seat the pen from the carriage alignment datums.

[0007] In the past, the printhead wipers have been a single or dual wiper blade made of an elastomeric material. Typically, the printhead is translated across the wiper in a direction parallel to the scan axis of the printhead. In one printer, the wipers were rotated about an axis perpendicular to the printhead scan axis to wipe. Today, most inkjet pens have nozzles aligned in two linear arrays which run perpendicular to the scanning axis. Using these earlier wiping methods, first one row of nozzles was wiped and then the other row of nozzles was wiped. This first generation of wipers was developed for replaceable cartridges, typically using a single elastomeric blade which had a rectangular wiping tip, and no draft angle to the side surfaces. The term "draft" is well

known to those in the molding arts, where a part is made with a slight angle to ease the release of the part from the mold. While these earlier wiping methods proved satisfactory for the traditional dye based inks, unfortunately, they were unacceptable for the newer fast drying pigment inks.

[0008] One suitable service station design for pigment-based inks was a rotary device first sold in the Hewlett-Packard Company's DeskJet® 850C and 855C color inkjet printers, and later in the DeskJet® 820C and 870C color inkjet printers. This rotary device mounted the wipers, primers and caps on a motor-operated tumbler. These pens were wiped using an orthogonal wiping technique, where the wipers ran along the length of the linear nozzle arrays, wicking ink along the arrays from one nozzle to the next to serve as a solvent to break down ink residue accumulated on the nozzle plate. This rotary service station used a dual wiper blade system, with special contours on each wiper blade tip to facilitate this wicking action and subsequent cleaning of the orifice plate.

[0009] Two other earlier inkjet printing mechanisms using replaceable cartridges were the models 690C and 693C DeskJet® inkjet printers sold by the Hewlett-Packard Company of Palo Alto, California, the present assignee. This system used dye-based color inks and a pigment-based black ink, which had different servicing needs than the dye-based color inks. In this earlier imaging system, the wipers had a rigid upright profile, and were each mounted on a spring-loaded arm to avoid excessive wiping forces which may otherwise damage the printheads. Both wipers were mounted on the same support platform for simultaneously wiping the two pens installed in the carriage.

[0010] To maintain the desired ink drop size and trajectory, the area around the printhead nozzles must be kept reasonably clean. Dried ink and paper fibers often stick to the nozzle plate and the cheek areas adjacent the nozzle plate, particularly on a wide tri-color pen, causing print quality defects if not removed. Wiping the nozzle plate only removes excess ink and other residue accumulated near the nozzle orifices, leaving the cheek regions unwiped to collect bits of dust, paper fibers and other debris. This cheek debris was then moved across a printed image by the printhead, smearing the printed ink and degrading print quality, a problem known as "fiber tracking."

[0011] To address this fiber tracking problem, a translational wiping system, using an orthogonal wiping stroke, was first sold by the Hewlett-Packard Company as the model 890C DeskJet® inkjet printer. To wipe the tri-color cartridge printhead, this system mounted a pair of auxiliary "cheek wipers" (also referred to by the designers as "mud flaps") to the wiper sled, adjacent a dual blade orifice plate wiper. There was no cheek wiping provided for the black printhead in this printer, which only used a dual-blade orifice plate wiper for the black pen. Thus, this system molded a total of six individual blades onto a stainless spring steel frame to form the wiper/mud flap assembly, two blades for the color orifice plate, two blades for the mud flaps, and two for the black orifice plate, all to service only two pens. The multitude of wiper blades made molding costly, not only in tooling costs, but all of these blades were difficult to remove as a unit from the mold, even using a one degree (1°) draft on the blades. Difficulty in removing the blades from the molds lead to a high scrap rate, and thus, an increased cost for the parts that were successfully made, which in turn, increased the overall cost of the printer.

Summary of the Invention

[0012] According to one aspect of the present invention, a dual-blade wiping system is provided for cleaning an inkjet printhead in an inkjet printing mechanism, with the printhead having an orifice plate that ejects ink therethrough and which is bordered by at least one cheek region. The dual-blade wiping system has a first wiper blade with a width wide enough to wipe both the orifice plate and the cheek region. The dual-blade wiping system also has a second wiper blade with a width wide enough to wipe only the orifice plate. A moveable platform supports both the first and second wiper blades for movement between a rest position and a wiping position for cleaning ink residue from the printhead with the first and second wiper blades through relative movement therebetween.

[0013] According to yet another aspect of the present invention, another wiping system is provided as including a wide wiper blade with a width wide enough to simultaneously wipe across both the orifice plate and the cheek region of the printhead. This wiping system also has a moveable platform that supports the wide wiper blade for movement between a rest position and a wiping position for cleaning ink residue from the printhead with the wide wiper blade through relative movement therebetween.

[0014] According to a further aspect of the present invention, a wiping system is provided for cleaning first and second inkjet printheads in an inkjet printing mechanism. Each printhead has an orifice plate that ejects ink therethrough and which is bordered by at least one cheek region. The wiping system includes a first dual-blade wiper assembly that has a wide wiper blade with a width wide enough to wipe both the orifice plate and the cheek region of the first printhead, and a narrow wiper blade with a width wide enough to wipe only the orifice plate of the first printhead. The wiping system also has a second dual-blade wiper assembly with a wide wiper blade having a width wide enough to wipe both the orifice plate and the cheek region of the second printhead, and a narrow wiper blade having a width wide enough to wipe only the orifice plate of the second printhead. This wiping system also has a moveable platform that supports the wide and narrow wiper blades of both the first and second wiper assemblies for move-

ment between a rest position and a wiping position for cleaning ink residue from the first and second printheads with the respective first and second wiper assemblies through relative movement therebetween.

[0015] According to a further aspect of the present invention, an inkjet printing mechanism may be provided with a printhead wiping system as described above.

[0016] An overall goal of the present invention is to provide an inkjet printing mechanism which prints sharp vivid images over the life of the printhead and the printing mechanism, particularly when using fast drying pigment or dye-based inks, and preferably when dispensed from an off-axis system.

[0017] Another goal of the present invention is to provide a wiping system for cleaning printheads in an inkjet printing mechanism to prolong printhead life.

[0018] Still another goal of the present invention is to provide a printhead wiping system for cleaning printheads in an inkjet printing mechanism, with the system having fewer parts that are easier to manufacture than earlier systems, and which thus provides consumers with a reliable, economical inkjet printing unit.

Brief Description of the Drawings

[0019]

FIG. 1 is a perspective view of one form of an inkjet printing mechanism, here, an inkjet printer, including a printhead service station having one form of a dual-wiper wiping system of the present invention for cleaning an inkjet printhead, and more specifically here, for wiping a black printhead and for wiping a group of color printheads.

FIG. 2 is a side elevational view of the service station of FIG. 1, including a single printhead dual-wiper assembly for wiping the black printhead, and a multiple printhead dual-wiper assembly for wiping the group of color printheads.

FIG. 3 is an enlarged, front perspective view of the color wiper assembly of FIG. 2.

FIG. 4 is an enlarged, front perspective view of the black wiper assembly of FIG. 2.

FIG. 5 is an enlarged, rear perspective view of the black wiper assembly of FIG. 2.

FIG. 6 is an enlarged, side elevational view of one form of the dual-wiper assembly of FIG. 2, showing a preferred wiping tip contour, suitable for wiping the black printhead and the color printheads.

FIG. 7 is an enlarged, side elevational view the dual-wiper assembly of FIGS. 4-6 shown wiping the black printhead.

FIG. 8 is an enlarged, front elevational view the dual-wiper assembly of FIGS. 4-6 shown wiping the black printhead.

FIG. 9 is an enlarged, front perspective view of a first alternate embodiment of the color wiper assembly of FIG. 2.

FIG. 10 is an enlarged, front perspective view of a second alternate embodiment of the color wiper assembly of FIG. 2.

Detailed Description of a Preferred Embodiment

[0020] FIG. 1 illustrates an embodiment of an inkjet printing mechanism, here shown as an "off-axis" inkjet printer 20, constructed in accordance with the present invention, which may be used for printing for business reports, correspondence, desktop publishing, and the like, in an industrial, office, home or other environment. A variety of inkjet printing mechanisms are commercially available. For instance, some of the printing mechanisms that may embody the present invention include plotters, portable printing units, copiers, cameras, video printers, and facsimile machines, to name a few, as well as various combination devices, such as a combination facsimile/printer. For convenience the concepts of the present invention are illustrated in the environment of an inkjet printer 20.

[0021] While it is apparent that the printer components may vary from model to model, the typical inkjet printer 20 includes a frame or chassis 22 surrounded by a housing, casing or enclosure 24, typically of a plastic material. Sheets of print media are fed through a printzone 25 by a media handling system 26. The print media may be any type of suitable sheet material, such as paper, card-stock, transparencies, photographic paper, fabric, mylar, and the like, but for convenience, the illustrated embodiment is described using paper as the print medium. The media handling system 26 has a feed tray 28 for storing sheets of paper before printing. A series of conventional paper drive rollers driven by a stepper motor and drive gear assembly (not shown), may be used to move the print media from the input supply tray 28, through the printzone 25, and after printing, onto a pair of extended output drying wing members 30, shown in a retracted or rest position in FIG. 1. The wings 30 momentarily hold a newly printed sheet above any previously printed sheets still drying in an output tray portion 32, then the wings 30 retract to the sides to drop the newly printed sheet into the output tray 32. The media handling system 26 may include a series of adjustment mechanisms for accommodating different sizes of print media, including letter, legal, A-4, envelopes, etc., such as a sliding length adjustment lever 34, a sliding width adjustment lever 36, and an envelope feed port 38.

[0022] The printer 20 also has a printer controller, illustrated schematically as a microprocessor 40, that receives instructions from a host device, typically a computer, such as a personal computer (not shown). The printer controller 40 may also operate in response to user inputs provided through a key pad 42 located on the exterior of the casing 24. A monitor coupled to the computer host may be used to display visual information

to an operator, such as the printer status or a particular program being run on the host computer. Personal computers, their input devices, such as a keyboard and/or a mouse device, and monitors are all well known to those skilled in the art.

[0023] A carriage guide rod 44 is supported by the chassis 22 to slideably support an off-axis inkjet pen carriage system 45 for travel back and forth across the printzone 25 along a scanning axis 46. The carriage 45 is also propelled along guide rod 44 into a servicing region, as indicated generally by arrow 48, located within the interior of the housing 24. A conventional carriage drive gear and DC (direct current) motor assembly may be coupled to drive an endless belt (not shown), which may be secured in a conventional manner to the carriage 45, with the DC motor operating in response to control signals received from the controller 40 to incrementally advance the carriage 45 along guide rod 44 in response to rotation of the DC motor. To provide carriage positional feedback information to printer controller 40, a conventional encoder strip may extend along the length of the printzone 25 and over the service station area 48, with a conventional optical encoder reader being mounted on the back surface of printhead carriage 45 to read positional information provided by the encoder strip. The manner of providing positional feedback information via an encoder strip reader may be accomplished in a variety of different ways known to those skilled in the art.

[0024] In the printzone 25, the media sheet 34 receives ink from an inkjet cartridge, such as a black ink cartridge 50 and three monochrome color ink cartridges 52, 54 and 56, shown schematically in FIG. 2. The cartridges 50-56 are also often called "pens" by those in the art. The black ink pen 50 is illustrated herein as containing a pigment-based ink. While the illustrated color pens 52-56 may contain pigment-based inks, for the purposes of illustration, color pens 52-56 are described as each containing a dye-based ink of the colors cyan, magenta and yellow, respectively. It is apparent that other types of inks may also be used in pens 50-56, such as paraffin-based inks, as well as hybrid or composite inks having both dye and pigment characteristics.

[0025] The illustrated pens 50-56 each include small reservoirs for storing a supply of ink in what is known as an "off-axis" ink delivery system, which is in contrast to a replaceable cartridge system where each pen has a reservoir that carries the entire ink supply as the printhead reciprocates over the printzone 25 along the scan axis 46. Hence, the replaceable cartridge system may be considered as an "on-axis" system, whereas systems which store the main ink supply at a stationary location remote from the printzone scanning axis are called "off-axis" systems. In the illustrated off-axis printer 20, ink of each color for each printhead is delivered via a conduit or tubing system 58 from a group of main stationary reservoirs 60, 62, 64 and 66 to the onboard reservoirs of pens 50, 52, 54 and 56, respectively. The stationary or main reservoirs 60-66 are replaceable ink supplies stored in a receptacle 68 supported by the printer chassis 22. Each of pens 50, 52, 54 and 56 have printheads 70, 72, 74 and 76, respectively, which selectively eject ink to form an image on a sheet of media in the printzone 25. The concepts disclosed herein for cleaning the printheads 70-76 apply equally to the totally replaceable inkjet cartridges, as well as to the illustrated off-axis semi-permanent or permanent printheads, although the greatest benefits of the illustrated system may be realized in an off-axis system where extended printhead life is particularly desirable.

[0026] The printheads 70, 72, 74 and 76 each have an orifice plate with a plurality of nozzles formed therethrough in a manner well known to those skilled in the art. The nozzles of each printhead 70-76 are typically formed in at least one, but typically two linear arrays along the orifice plate. Thus, the term "linear" as used herein may be interpreted as "nearly linear" or substantially linear, and may include nozzle arrangements slightly offset from one another, for example, in a zigzag arrangement. Each linear array is typically aligned in a longitudinal direction perpendicular to the scanning axis 46, with the length of each array determining the maximum image swath for a single pass of the printhead. The illustrated printheads 70-76 are thermal inkjet printheads, although other types of printheads may be used, such as piezoelectric printheads. The thermal printheads 70-76 typically include a plurality of resistors which are associated with the nozzles. Upon energizing a selected resistor, a bubble of gas is formed which ejects a droplet of ink from the nozzle and onto a sheet of paper in the printzone 25 under the nozzle. The printhead resistors are selectively energized in response to firing command control signals delivered by a multi-conductor strip 78 from the controller 40 to the printhead carriage 45.

[0027] FIG. 2 illustrates one form of a dual-blade wiping service station 80 constructed in accordance with the present invention. The service station 80 includes a frame 82 which is supported by the printer chassis 22 in the servicing region 48 within the printer casing 24. To service the printheads 70-76 of the pens 50-56, the service station 80 includes a moveable platform supported by the service station frame 82. Here, the servicing platform is shown as a rotary member supported by bearings or bushings (not shown) at the service station frame 82 for rotation, as illustrated by arrow 83, about an axis 84, which in the illustrated embodiment is parallel with printhead scanning axis 46. The illustrated rotary member comprises a tumbler body 85 which may have a drive gear 86 that is driven by a conventional service station motor and drive gear assembly (not shown). The tumbler 85 carries a series of servicing components, such as a capping assembly 88, into position for servicing the printheads 70-76. The capping assembly 88 preferably includes four discrete caps for sealing each of the printheads 70-76, although only a

single capping unit is visible in the view of FIG. 2. The tumbler 85 may also be mounted to the service station frame 82 for movement in a vertical direction, as indicated by the double-headed arrow in FIG. 2, to facilitate capping. Alternatively, the capping assembly 88 may be mounted to the tumbler 85 to move upwardly away from tumbler 85 when moved into contact with the pens 50-56 or the carriage 45, for instance, using the capping strategy first sold by the present assignee, Hewlett-Packard Company of Palo Alto, California, in the models 850C and 855C DeskJet® inkjet printers.

[0028] Other servicing components carried by the rotary platform 85 include a black dual-blade wiper 90 for servicing the black printhead 70, and three color dual-blade wipers 92, 94 and 96 for servicing the respective color printheads 72, 74 and 76, although in the side view of FIG. 2, the yellow wiper 96 obscures the view of the cyan and magenta wipers 92, 94. Preferably, each of the wipers, 90-96 is constructed of a flexible, resilient, non-abrasive, elastomeric material, such as nitrile rubber, or more preferably, ethylene polypropylene diene monomer (EPDM), or other comparable materials known in the art. For wipers 90-96, a suitable durometer, that is, the relative hardness of the elastomer, may be selected from the range of 35-80 on the Shore A scale, or more preferably within the range of 60-80, or even more preferably at a durometer of 70 +/- 5, which is a standard manufacturing tolerance.

[0029] By placing the black wiper 90 along a different radial location on tumbler 85 than the radial on which the color wipers 92-96 are located, here, with the black and color wipers being shown 180° apart for the purposes of illustration, advantageously allows different wiping schemes to be employed for cleaning the black printhead 70 and for cleaning the color printheads 72-76. For instance, the color pens 52-56 carrying dye-based irks may be wiped using a faster wiping speed than required for wiping the black pen 50 which dispenses a black pigment-based ink. In the past, many service stations used wipers that required both the black and color printheads to be wiped simultaneously, so compromises had to be made between the optimum wiping speeds for the black pigment-based ink ad the color dye-based inks. Problems were encountered in the past because the slower wiping strokes required to clean the black printheads extracted excess ink from the color printheads. When using a faster wiping stroke for the color pens, without allowing excess time for the color ink to seep out between the orifice plate and the wipers, the black wiper would then skip over black ink residue on the black printhead. These problems are avoided by service station 80, which places the black wiper 90 and the color wipers 92-96 at different locations around the periphery of the tumbler 85, thus allowing wiping to be optimized for both the black printhead 70 and for the color printheads 72-76.

[0030] As mentioned in the Background section above, the advent of permanent or semi-permanent inkjet printheads for use in off-axis printers, such as printer 20, particularly those using different types of ink, such as a pigment-based black ink and dye-based color inks, has proved challenging for service station designers. New servicing approaches were required to clean and maintain the pens without unnecessarily shortening the printhead lifespan. In studying various servicing routines, it was felt that use of an ink solvent may be the optimum approach to printhead cleaning. In particular, it would be even more desirable if the ink solvent also served to lubricate the printhead orifice plates during wiping, which would then avoid unnecessary wear or damage to the printheads, thereby insuring a long printhead life. To this end, the service station 80 includes a solvent dispensing system 98, mounted along the lower portion of the service station frame 82 in location where the wipers 90-96 can be coated with the solvent prior to wiping the printheads 70-76. The solvent dispensing system 98 also has a wiper cleaner portion to remove ink residue and any remaining solvent from the wipers after cleaning the printheads in a wiping cycle. The inkjet ink solvent used in system 98 may be a hygroscopic material, such as polyethylene glycol ("PEG"), Lipponic-ethylene glycol ("LEG"), diethylene glycol ("DEG"), glycerin or other materials known to those skilled in the art as having similar properties. These hygroscopic materials are liquid or gelatinous compounds that will not readily evaporate during extended periods of time because they have a large molecular size which leads to a extremely low vapor pressure. For the purposes of illustration, the preferred ink solvent used in system 98 is PEG.

[0031] FIG. 3 shows a first embodiment of a color wiper assembly 100, constructed in accordance with the present invention, as including a wiper mounting member or platform 102 upon which the color wipers 92-96 are mounted, and preferably molded to the platform 102 using onsert molding techniques. While it is apparent to those skilled in the art that the wipers 92-96 may be onsert molded directly onto the tumbler 85, in the preferred embodiment the mounting platform 102 is used. The mount 102 is constructed of a sheet of metal, such as a spring steel, and more preferably of a stainless spring steel which may be bent and formed to provide a removable platform 102 for assembly onto the tumbler 85.

[0032] The platform 102 may begin as a long strip of stainless spring steel which is first punched in a flat state to define several features of its final construction, including a series of holes (not shown) extending through this strip in the region under the wipers 92-96, which are used as knit holes to onsert mold the wipers 92-96 to the platform 102. Indeed, a series of mounting platforms 102 may be formed along a single strip of steel, so that several sets of wipers may be onsert molded in a single step. Then in one or more finishing operations, each of these individual platforms are severed from one another and their sides are turned down

to form ears 104 at each end, as well as engagement tabs 105 having slots 106 therethrough. When forming the knit holes, other mounting holes 108 may also be formed through the platform 102 to serve as assembly points through which posts extending from the tumbler 85 are received. This manner of mounting the wiper assembly 100 to the tumbler 85 is similar to that used to mount the printhead wipers in the commercially available DeskJet® model 890C inkjet printer, sold by the Hewlett-Packard Company of Palo Alto, California, the present assignee.

[0033] Each of the color wipers 92-96 is a dual-blade structure, having a little brother wiper or blade 110 extending upwardly from a common base portion 112, constructed of the same elastomer as the wipers 92-96, and used to strengthen the bond of the wipers to the platform 102. Each of the little brother wipers 110 is wide enough to wipe across the orifice plate of the color printheads 72-76. To this end, each of the little brother wipers 110 has an outboard wiping surface 114 and an opposing inboard wiping surface 116. Each of the wipers 110 terminates in a wiping tip 118, which has a angular wiping edge adjacent to the inboard surface 116, and a rounded wiping edge adjacent the outboard surface 114, as illustrated for the little brother blade 110 of wiper 92 in FIG. 3.

[0034] The other portion of the dual-blade structure of the color wipers 92-96 is a big brother wiper or blade 120, which also extends upwardly from the base 112. Each of the big brother wipers 120 has a width which is wide enough to not only wipe the orifice plate, but to also wipe both cheek regions of the printhead adjacent the orifice plate, as illustrated in further detail below with respect to FIG. 8. Each of the big brother wipers 120 has an outboard wiping surface 124, and an opposing inboard wiping surface 126. Each of the big brother blades 120 terminates in a wiping tip 128. The illustrated wiping tip 128 is angular along an edge adjacent the inboard surface 126, and rounded or tapered along an edge adjacent to the outboard surface 124, as illustrated with respect to the big brother blade 120 of wiper 96 in FIG. 3.

[0035] FIGS. 4 and 5 illustrate a black wiper assembly 130 constructed in accordance with the present invention for wiping the black printhead 70 of pen 50. The black wiper assembly 130 includes a mounting member or platform 132, which may be constructed as described above for the color wiper assembly platform 102. Here, the black wiper platform 132 is constructed with mounting ears 134, a mounting tab 135 having a slot 136 therethrough, and several mounting holes 138 used to secure the black wiper platform 132 to the tumbler 85, preferably in the same manner as described above for securing the color wiper platform 102 to tumbler 85.

[0036] The black wiper assembly 130 includes a little brother wiper or blade 140 which extends upwardly from a base portion 142. The base 142 is integrally molded of the same elastomer as the blade 140, ad used to secure the blade to platform 132 during the onsert molding process, as described above for the color base 112. The little brother wiper 140 is wide enough to wipe across the orifice plate of the black printhead 70. The blade 140 includes an outboard wiping surface 144, and an opposing inboard wiping surface 146. The little brother blade 140 terminates in a wiping tip 148, which has an angular edge adjacent to the inboard surface 146, and a rounded or tapered edge blending into the outboard surface 144.

[0037] The black wiper assembly 130 is a dual-blade structure, and includes a big brother wiper or blade 150 which also extends upwardly from base 142, and is formed integral therewith, to secure the big brother blade 150 to the black wiper platform 132. The big brother blade 150 is wide enough to wipe across the entire surface of the black printhead 70, including the orifice plate and both cheek regions along each side of the orifice plate. The big brother blade 150 includes an outboard wiping surface 154, and an opposing inboard wiping surface 156. The big brother blade 150 terminates in a wiping tip 158, which has an angular junction with the inner wiping surface 156, and a rounded or tapered edge blending into the outer wiping surface 154.

[0038] FIG. 6 shows a side view of the black wiper assembly 130 to better illustrate a preferred contour for the wiping tips 148, 158 of blades 140, 150. Preferably, the inboard and outboard surfaces 144, 146 ad 154, 156 of blades 140 and 150 are each molded with a large draft angle, preferably on the order of 1.5 degrees. This large draft angle advantageously helps reduce the force the wiper tips 148, 158 apply against the printheads 70-76, since this force is proportional to the cube of the cross sectional blade thickness T shown in FIG. 6, e.g., $F \propto T^3$. Use of a tapered configuration advantageously maintains a secure mount at the base portions 112, 142 while reducing the wiping force seen by the printheads 70-76. Additionally, use of this large draft angle aids in filling the molds, as well as removing the wiper assembly 130 from the wiper molds, so fewer parts are scrapped out, leading to overall economies in producing the wiper assemblies. Preferably, the color wiper assembly 100 is also constructed with each of the blades 110, 120 of wipers 92-96 having the same contours as illustrated in FIG. 6 for blades 140 and 150, to achieve these advantages.

[0039] FIG. 7 illustrates the black wiper assembly 130 being carried by tumbler 85 to wipe printhead 70 of the black pen 50. It is apparent that tumbler 85 may rotate either in the direction indicated by arrow 83, or in the opposite direction to first present the little brother blade 140 to the printhead, followed by wiping with the big brother blade 150. In the preferred wiping scheme, the tumbler 85 rotates in the direction of arrow 83 to first wipe printhead 70 with the big brother wiper 150.

[0040] FIG. 8 shows a rear elevational view of the preferred wiping process. Here, the printhead 70 is shown

as having an orifice plate 160 of a width A, which is roughly the width of little brother wiper 140, and a pair of cheek regions 162 having substantially equal widths B ad C, located to each side of the orifice plate 160. The ink-ejecting nozzles are formed through the orifice plate 160, preferably arranged in two substantially linear, mutually parallel arrays. The little brother wiper 140 preferably has a width which is wide enough to sweep across both nozzle arrays in a direction parallel thereto (sweeping along the length of both arrays simultaneously), with enough extra width to accommodate for any manufacturing or assembly tolerances typically encountered, to assure adequate wiping contact with each nozzle of the orifice plate 160. The color printheads 72-76 have a similar geometry, each having a pair of cheeks flanking the orifice plate, so the wiping operation of FIG. 8 is also representative of the wiping process for the color wipers 92-96. During the preferred wiping process in the direction of arrow 83 (which would point into the drawing sheet in the view of FIG. 8), the leading edge of the big brother wiping tip 158 is rounded, while the trailing little brother blade 140 has the angular portion of the wiping tip 148 contacting the printhead 70. When wiping in the opposite direction, the leading edge of the little brother wiping tip 148 is rounded, while the trailing big brother blade 150 has the angular portion of the wiping tip 158 contacting the printhead 70.

[0041] As illustrated in FIG. 7, the rounded wiping edge 158 of the leading blade 150 forms a capillary passageway 164 into which ink is wicked, or extracted through capillary forces, from the printhead nozzles into the small crevice between the orifice plate and the rounded leading edge of blade 158. This wicked ink then acts as a solvent to dissolve ink residue remaining on the orifice plate 160. The angular portion of the trailing wiper tip 148 is then used to scrape clean the orifice plate, removing any of this wicked ink and dissolved residue from the orifice plate 160. The big brother and little brother blades 110, 120 of the color wipers 92-96 may be constructed with wiping tips 118, 128 to function as described with respect to FIGS. 7 and 8 for the black wiper assembly 130. It is apparent that other contours may be used for the wiping tips 118, 128, 148 and 158, such as use of a rectangular wiping tip, or tips having other contours, but the preferred embodiment for these wiping tips is illustrated herein.

[0042] FIG. 9 illustrates another embodiment comprising an alternating wiper assembly 100' which may be substituted for assembly 100 to clean the color printheads 72-76. Here, the alternating wiper assembly 100' has a platform 102 which may constructed as described above, and a wiper base 112' which may also be fashioned as described above for base 112. The color wiper assembly 100' has cyan and yellow wipers 92 and 96 as described above, but a modified wiper assembly 94' for cleaning the magenta printhead 74. Here, the magenta wiper 94' has the locations of the big brother and little brother wipers 120, 110 reversed from that shown for the magenta wiper 94 of assembly 100 in FIG. 3. Such an alternating color wiper assembly 100' may be particularly advantageous for use in a wiping system which wipes bi-directionally across the printheads 92-96. Alternatively, the alternating color wiper assembly 100' may be useful where the magenta ink in pen 54 has different properties than the cyan and yellow inks in pens 52 and 56.

[0043] FIG. 10 illustrates a third embodiment which may be substituted for assemblies 100 and 100', here shown as a unified blade color wiper assembly 100", constructed in accordance with the present invention. The unified blade wiper assembly 100" includes a platform 102 which may be constructed as described above, and a wiper base 112" serving the same functions as discussed above with respect to base 112 in FIG. 3. Here, the unified blade assembly 100" has wipers 92", 94" and 96" for wiping the color printheads 72, 74 and 76, respectively. Each of the wipers 92", 94", 96" includes a little brother wiper or blade 110, for wiping the orifice plates of printheads 72-76. However, rather than having three individual big brother wiper blades 120, wipers 92", 94" and 95" each share a portion of a unified wiper blade 170, which has a first portion 172, a second portion 174, and a third portion 176, dedicated to wiping the orifice plates and cheeks of printheads 72, 74, and 76, respectively. The unified wiper blade 170 has a outboard surface 124', an inboard surface 126', and a wiping tip 128', Which may be constructed to have the same contours as described above for surfaces 124, 126 and tip 128 of the big brother blade 120.

[0044] Use of the unified blade 170 in wiper assembly 100" may be preferred over the big brother blades 120 of the color wiper assemblies 100 and 100' because fewer parts are required to form the unified assembly 100". That is, use of the unified blade 170, while requiring slightly more in material cost, may prove to be a more economical design than illustrated for assemblies 100 and 100', because fewer mold cavities need to be made. The unified assembly 100" only needs four mold cavities (three for blades 110, and one for blade 170), which results in a more economically manufactured mold. Additionally, the unified blade 170 may be easier to remove from the mold than the individual big brother blades 120, yielding lower scrap rates and more acceptable parts, which then may be produced more economically. Additionally, use of the unified blade 170 may be helpful in removing any debris or fibers clinging between the pens 50-56, which may otherwise trail down onto the printed image creating fiber tracks, a problem discussed above in the Background section.

Conclusion

[0045] A variety of advantages are realized using the dual-blade, big brother/little brother wiping systems 100, 130, 100' and 100" described herein, and several of these advantages have been noted above. For exam-

ple, these dual-blade wiping systems have been found to reduce the forces exerted on printheads 70-76, in both a normal direction, that is, directly upright into the surface of the orifice plates, and in a tangential or wiping direction, using the rotary platform 85 as the wipers are moved in a arc across printheads 70-76. This reduction in both normal and tangential forces applied to the pens 50-52 during wiping is important, because excessive forces during wiping could potentially unseat the pens 50-56 from their alignment datums inside the printhead carriage 45.

[0046] Another advantage realized using the dual-blade wiping systems 100, 130, 100' and 100" is that the normal and normal tangential forces experienced by the printheads 70-76 during wiping are reduced. This reduction in force is important, because otherwise the substrate forming the orifice plates of printheads 70-76 could potentially be damaged under excessive forces. Additionally, it is important that the wipers do not scratch the orifice plate, or damage the individual orifice holes, which would then effect the ink ejection trajectory and ruin print quality. Avoiding orifice plate damage is of particular concern for printheads constructed using plastic orifice surfaces, where the nozzles themselves could be easily damaged through a deformation known as "ruffles," where a portion of the orifice plate adjacent the nozzle is deflected upwardly so the nozzle orifice no longer resides in a single plane, leading to misdirected droplet ejection.

[0047] A further advantage noted above, is the use of the big brother wipers 120, 150, 170 to clean not only the orifice plate, but also to clean the cheek regions adjacent the orifice plates, such as cheek regions 162 in FIG. 8. Cleaning of the cheek regions then removes any dust, debris or fibers which may be clinging to the cheeks, to avoid the fiber tracking problem described in the Background section above. This fiber tracking problem is of particular concern when using long-life printheads, such as those of pens 50-56 in the illustrated off-axis printer 20.

[0048] Finally, the illustrated dual-blade wiper systems 100, 130, 100' and 100" are believed to be easier to manufacture than their predecessor wiper systems described in the Background above. Ease of molding and manufacture not only leads to lower tooling costs in initially preparing the molds, but also in a lower scrap rate, as more acceptable quality parts are produced. Use of the tapered cross sectional configuration of the blades facilitates the mold filling process, decreases the cooling time and thus the overall molding cycle time, as well as leaving less elastomer debris in the molds, so less down-time is required to clean the molds. Basically, by having fewer blades molded to service each pen 50-56, the parts are easier to mold, further leading to a lower scrap-out rate, and ultimately to a more economical and reliable inkjet printing unit 20 for consumers.

Claims

1. A wiping system (100; 100'; 100"; 130) for cleaning an inkjet printhead (70, 72, 74, 76) in an inkjet printing mechanism (20), with the printhead having an orifice plate (160) that ejects ink therethrough and which is bordered by at least one cheek region (162), comprising:

   a first wiper blade (120; 150; 170) having a width wide enough to wipe both the orifice plate (160) and the cheek region (162);
   a second wiper blade (110; 140) having a width wide enough to wipe only the orifice plate (160); and
   a moveable platform (85) that supports both the first and second wiper blades (110, 120; 140, 150; 110, 170) for movement between a rest position and a wiping position for cleaning ink residue from the printhead (70, 72, 74, 76) with the first and second wiper blades (110, 120; 140, 150; 110, 170) through relative movement therebetween.

2. A wiping system according to claim 1 wherein the first and second wiper blades (110, 120; 140, 150; 110, 170) are spaced apart to define a interior region therebetween, with the first and second wiper blades each having opposing inboard and outboard surfaces (126, 124; 116, 114; 156, 154; 146, 144; 126', 124'), with the inboard surfaces (126; 116; 156; 146; 126') of each blade facing toward the interior region, wherein each blade terminates in a wiping edge (128, 118; 158, 148) having a rounded surface joining the outboard surface (124; 114; 154; 144; 124'), and the wiping edge of each blade terminates angularly with the inboard surface (126; 116; 156; 146; 126').

3. A wiping system according to claims 1 or 2 for cleaning an inkjet printhead having two cheek regions (162) adjacent opposing sides of the orifice plate (160), wherein the width of the first wiper blade (120; 150; 170) is wide enough to wipe the orifice plate (160) and the two cheek regions (162).

4. A wiping system for cleaning an inkjet printhead (70, 72, 74, 76) in an inkjet printing mechanism (20), with the printhead having an orifice(120; 150; 170) plate (160) that ejects ink therethrough and which is bordered by at least one cheek region (162), comprising:

   a wide wiper blade (120; 150; 170) having a width wide enough to simultaneously wipe across both the orifice plate (160) and the cheek region (162); and
   a moveable platform (85) that supports the

wide wiper blade (120; 150; 170) for movement between a rest position and a wiping position for cleaning ink residue from the printhead (120; 150; 170) with the wide wiper blade (120; 150; 170) through relative movement therebetween.

5. A wiping system according to claim 4, further including a narrow wiper blade (110; 140) having a width wide enough to wipe only the orifice plate (160), with the narrow wiper blade (110; 140) supported by the platform (85) for movement between a rest position and a wiping position for cleaning ink residue from the printhead (70, 72, 74, 76) with the narrow wiper blade (110; 140) through relative movement therebetween.

6. A wiping system according to claims 4 or 5 for cleaning another printhead in the inkjet printing mechanism (20), with said another printhead also having an orifice plate (160) that ejects ink therethrough and which is bordered by at least one cheek region (162), wherein the width of the wide wiper blade (170) is wide enough to simultaneously wipe across the orifice plates and cheek regions of said printhead and said another printhead.

7. A wiping system (100; 100'; 100") for cleaning first and second inkjet printheads (72, 74, 76) in an inkjet printing mechanism (20), with each printhead having an orifice plate (160) that ejects ink therethrough and which is bordered by at least one cheek region (162), comprising:

a first dual-blade wiper assembly (92, 94, 96; 92, 94', 96; 92", 94", 96") having (a) a wide wiper blade (120; 170) having a width wide enough to wipe both the orifice plate (160) and the cheek region (162) of the first printhead (72, 74, 76), and (b) a narrow wiper blade (110) having a width wide enough to wipe only the orifice plate (160) of the first printhead (72, 74, 76);

a second dual-blade wiper assembly (92, 94, 96; 92, 94', 96; 92", 94", 96") having (a) a wide wiper blade (120; 170) having a width wide enough to wipe both the orifice plate (160) and the cheek region (162) of the second printhead (72, 74, 76), and (b) a narrow wiper blade (110) having a width wide enough to wipe only the orifice plate (160) of the second printhead (72, 74, 76); and

a moveable platform (85) that supports the wide ad narrow wiper blades of both the first and second wiper assemblies for movement between a rest position and a wiping position for cleaning ink residue from the first and second printheads with the respective first and second wiper assemblies through relative movement therebetween.

8. A wiping system (100) according to claim 7 wherein the wide wiper blades (120) of both the first and second wiper assemblies (92, 94, 96) are arranged side-by-side in a first line along the moveable platform (85), and the narrow wiper blades (110) of both the first and second wiper assemblies (92, 94, 96) are arranged side-by-side in a second line along the moveable platform (85).

9. A wiping system (100') according to claim 7 wherein the wide wiper blade (120) of the first wiper assembly (92, 94, 96) and the narrow wiper blade (110) of the second wiper assembly (92, 94, 96) are arranged side-by-side in a first line along the moveable platform (85), and the narrow wiper blade (110) of the first wiper assembly (92, 94, 96) and the wide wiper blade (120) of the second wiper assembly (92, 94, 96) are arranged side-by-side in a second line along the moveable platform (85).

10. An inkjet printing mechanism (20), comprising:

an inkjet printhead (70, 72, 74, 76) having an orifice plate (160) that ejects ink therethrough and which is bordered by at least one cheek region (162);

a carriage (45) that reciprocates the printhead (70, 72, 74, 76) through a printzone (25) for printing and to a servicing region (48) for printhead servicing; and

a wiping system according to any of claims 1 through 9.

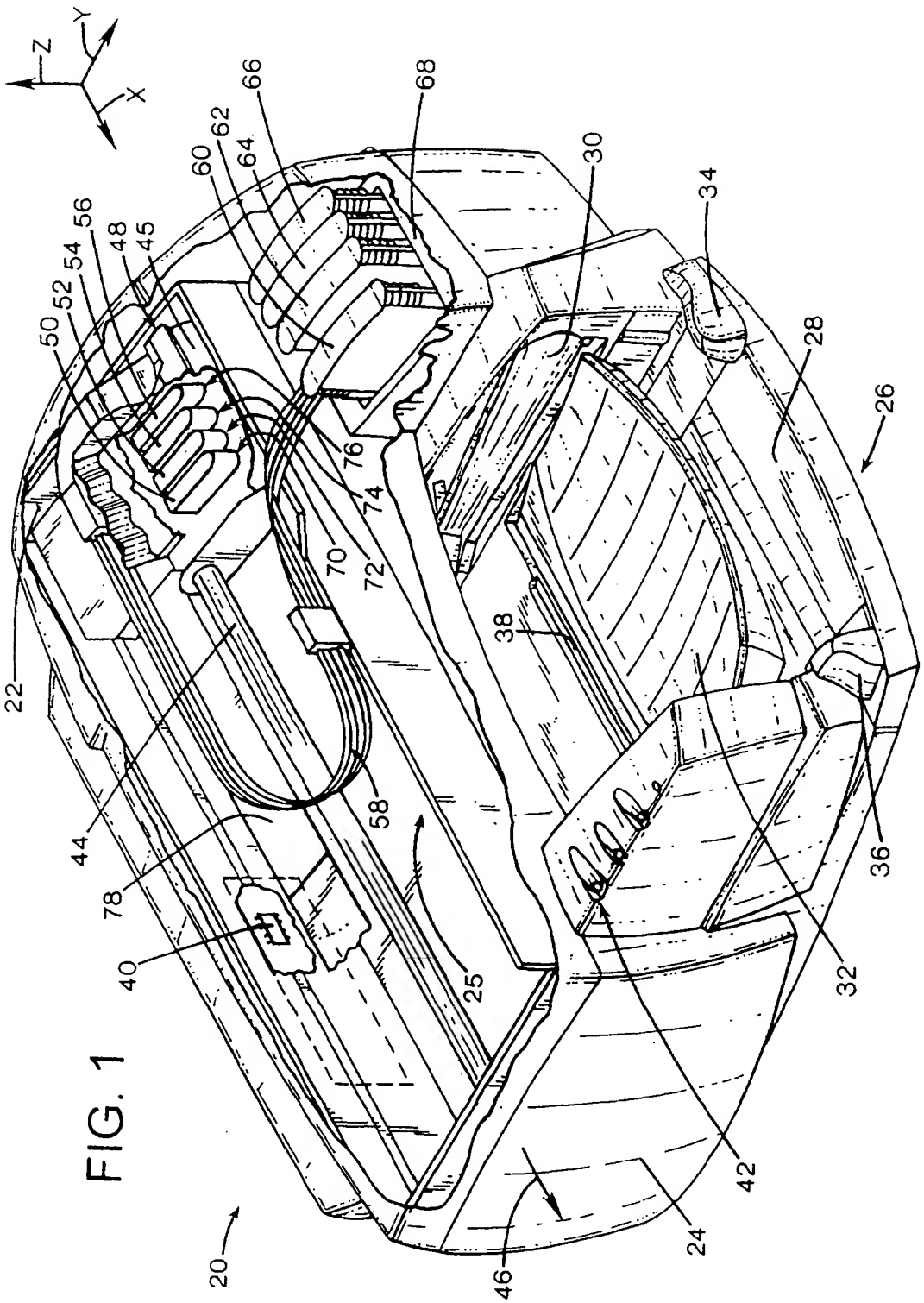
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FIG. 1

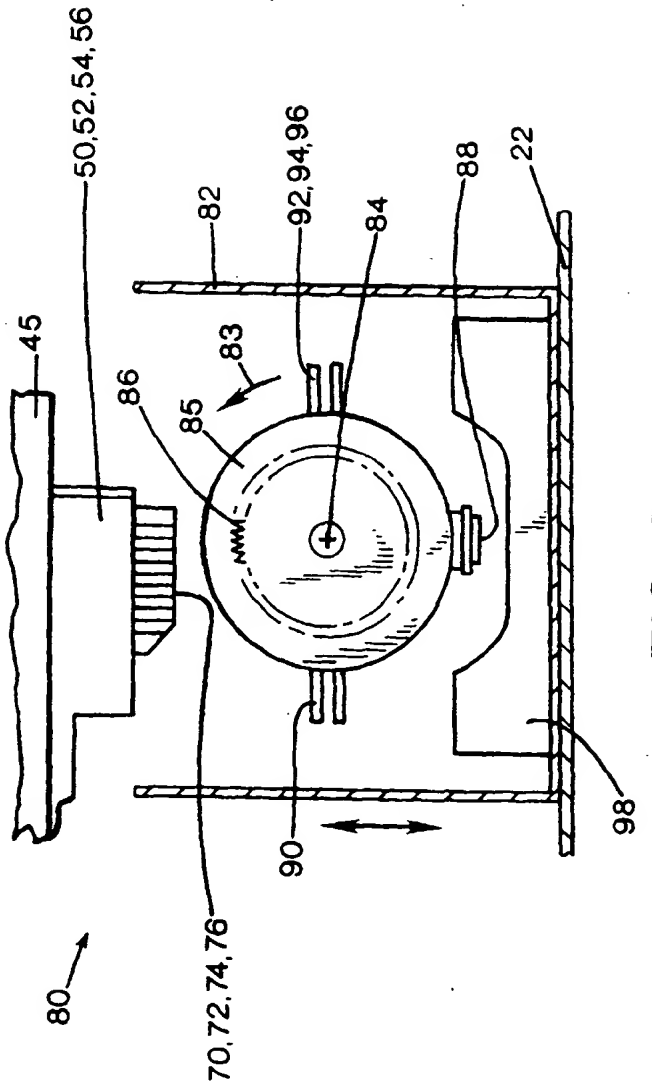
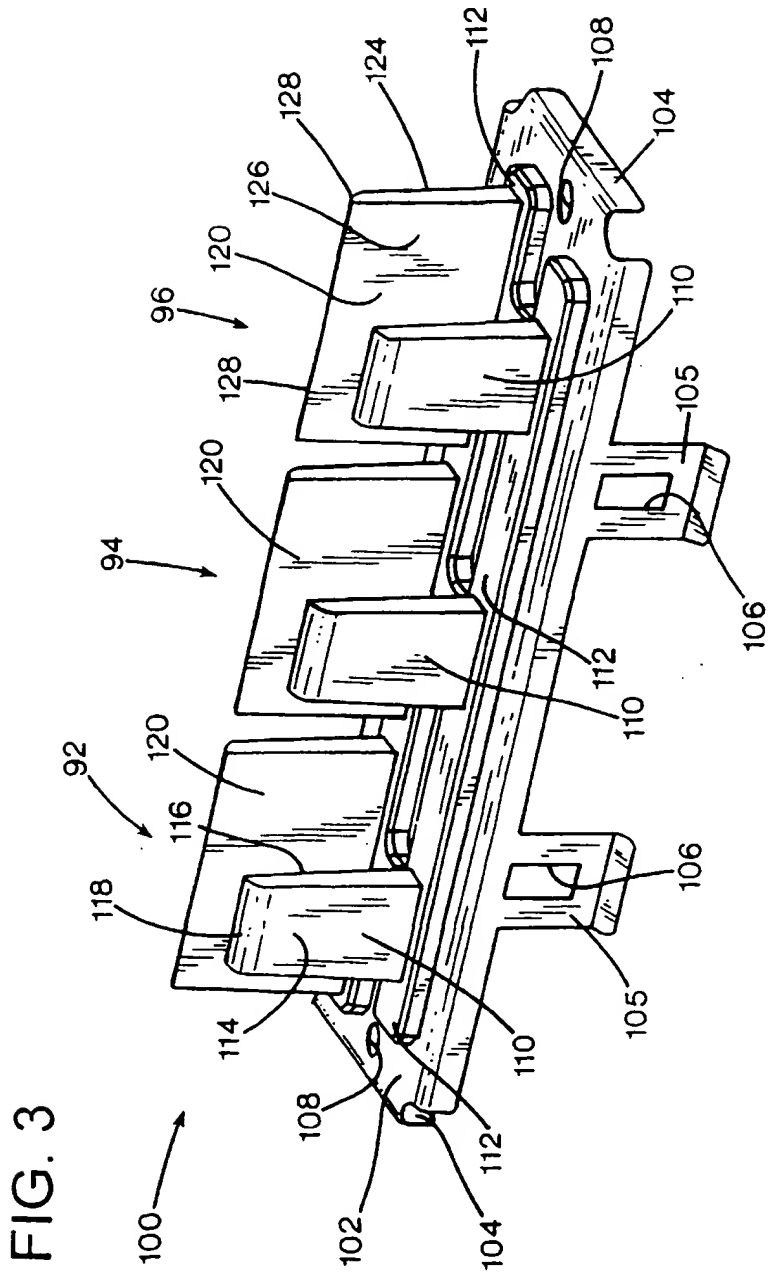


FIG. 2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104
100

FIG. 3

FIG. 4

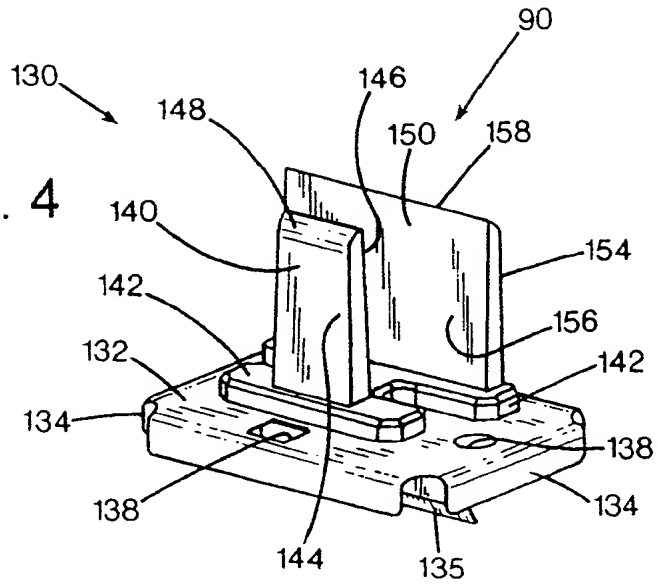


FIG. 5

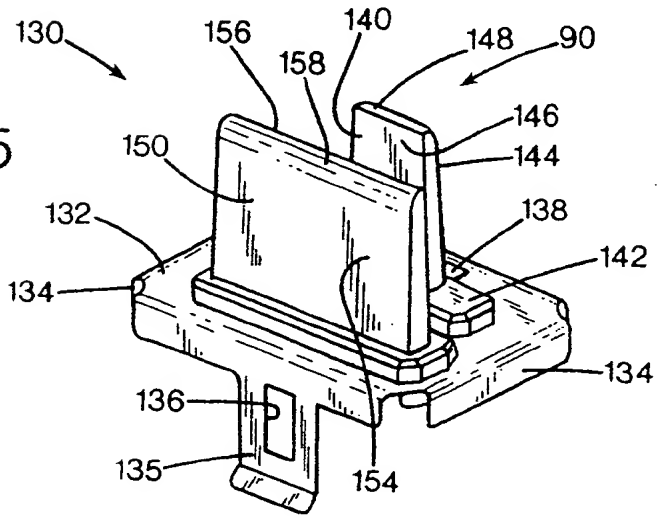
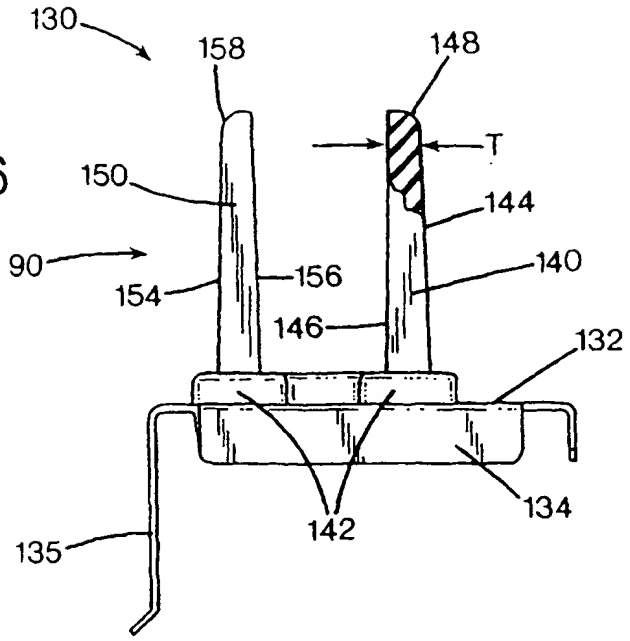


FIG. 6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158
148
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150
144
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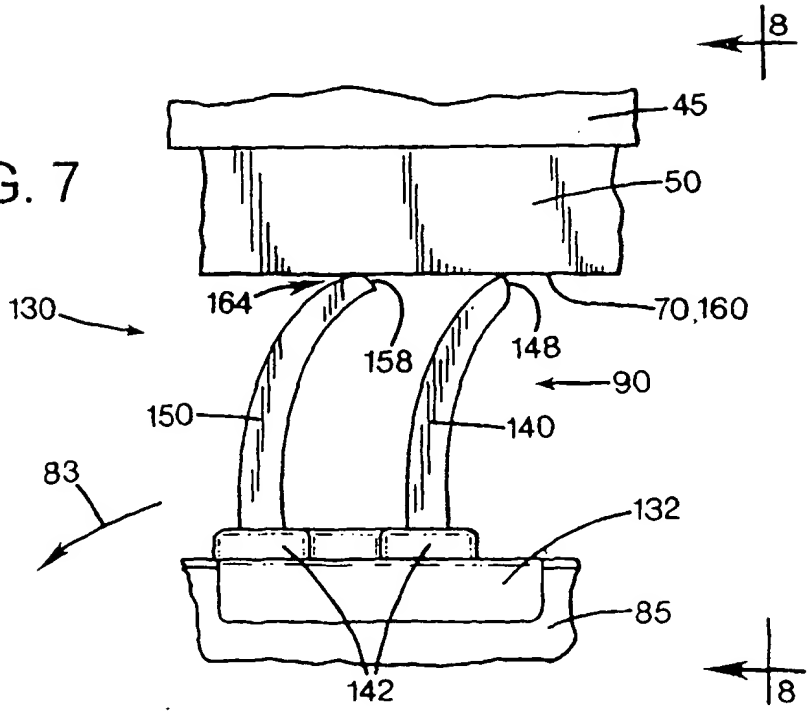
156
146
132
134
142
135

FIG. 7


8
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85
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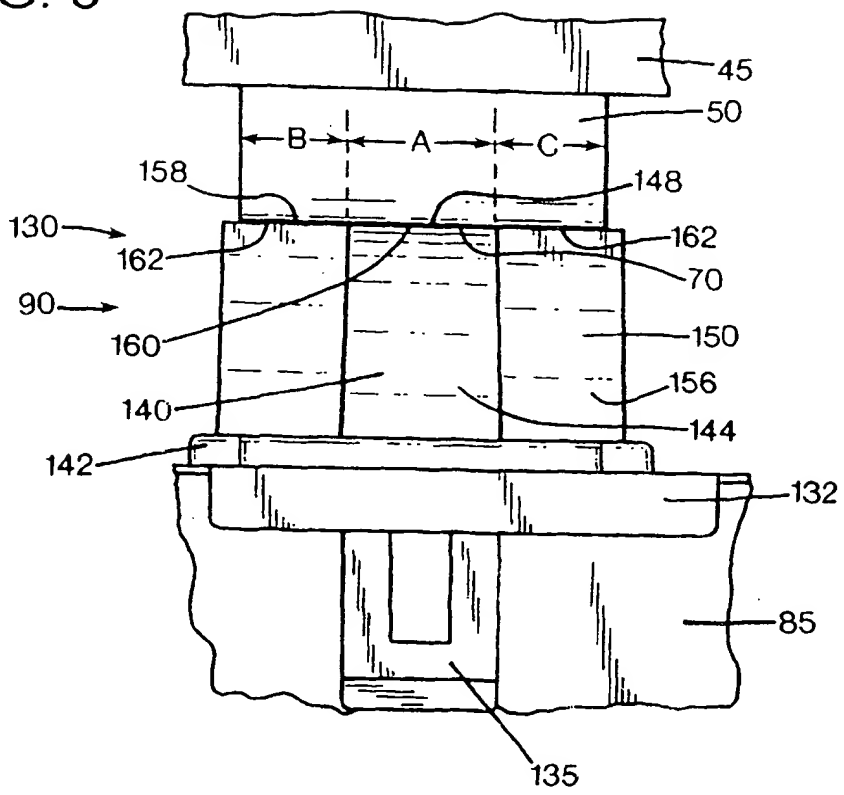
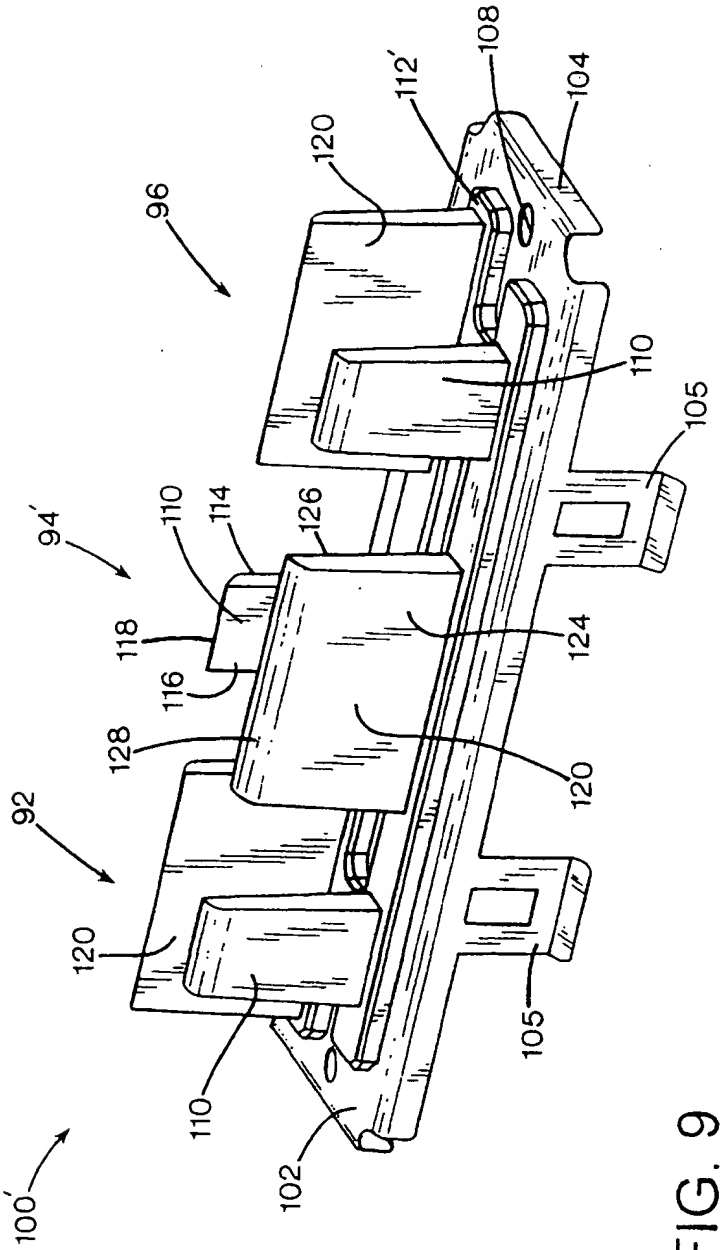
8

FIG. 8




108
112'
104
120
96
110
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94'
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114
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118
124
116
128
120
92
120
105
110
102
100'

FIG. 9

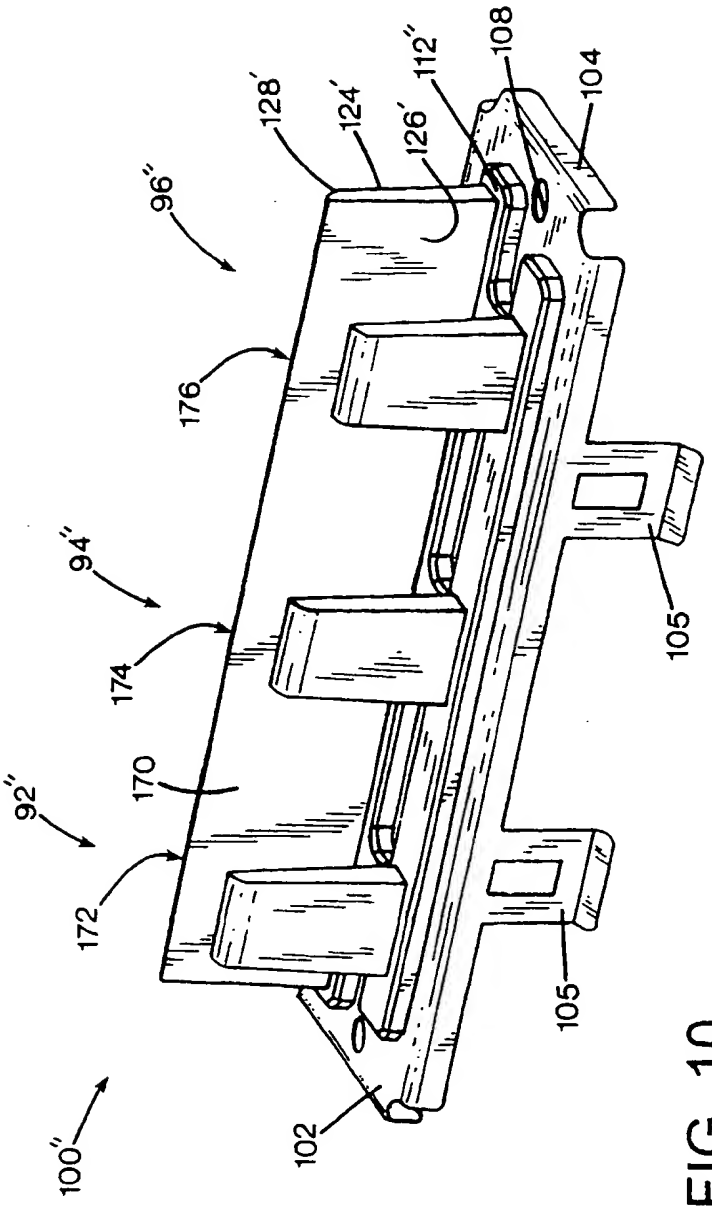

FIG. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 11 2905

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	25 January 1999	Nielsen, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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